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AN INVESTIGATION INTO PARTICULATE LEVELS IN THE AMBIENT AIR OF THE BEACHVILLE AREA

October, 1978 to July, 1979

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Ministry
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The Honourable
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Minister

Graham W. S. Scott,
Deputy Minister

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AN INVESTIGATION INTO

PARTICULATE LEVELS IN THE

AMBIENT AIR OF THE

BEACHVILLE AREA

October, 1978 to July, 1979

Technical Support Section
Southwestern Region
ONTARIO MINISTRY OF THE ENVIRONMENT
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SUMMARY

From October, 1978 to July, 1979 ambient air quality monitoring was intensified in the Beachville area in an effort to determine the influence that the limestone quarries and processing operations of The Steel Company of Canada, Limited (Stelco), BeachviLime Limited, and Domtar Inc. had on particulate levels. Additional samplers were deployed to collect dustfall and total suspended particulate matter and a meteorological tower was erected.

Analytical data revealed that higher-than background levels of dustfall and total suspended particulate matter were experienced on private property in the Beachville area and that elevated levels of total suspended particulate matter tended to be associated with winds blowing from the quarries and processing operations. Interpretation of meteorological and particulate data indicates that the operations of Domtar Inc. were most clearly associated with elevated levels of particulates while the operations of BeachviLime Limited were less distinctly associated and those of Stelco even less.

Visual observations revealed emissions from point sources within the processing operations that had opacities greater than stipulated in Regulation 15 of The Environmental Protection Act. Fugitive sources, including dusty company and county roads, were noted to contribute appreciable amounts of particulates.

It is recommended that steps be taken to optimize the control of fugitive emissions and that point sources of particulate emissions be brought into compliance with Regulation 15.

INTRODUCTION

In the Beachville area, The Steel Company of Canada, Limited (Stelco), BeachviLime Limited, and Domtar Inc. operate limestone quarries and associated processing operations which are located side-by-side in a southwest to northeast direction. There has been a history of complaints from citizens regarding emissions of particulates from the plants and, with time, the companies have increased both production capacity and controls on particulate emissions. However, complaints regarding excessive emissions persist and staff of the Ministry of the Environment have observed vegetation and private property soiled with white dust.

Owing to the many individual sources of particulates associated with the operations of each company and the proximity of the three complexes to each other it has been difficult to determine the sources of particulates that should be more stringently controlled. In 1978 the Ministry of the Environment increased its ambient air monitoring in the Beachville area in order to evaluate the levels of particulate matter and the significance of different sources of particulates.

DESCRIPTION OF SURVEY

Monitoring for particulates in the ambient air of the Beachville area began in 1968 with the installation of jars to collect dustfall. Since then dustfall jars have been exposed on a monthly basis for 30-day periods. In 1974 the dustfall jars were supplemented with a sampler designed to collect total suspended particulate matter (TSP). During a 24-hour period the TSP sampler draws a measured volume of ambient air through a pre-weighed filter, trapping particulate matter on the filter which is subsequently sent to a Ministry laboratory for analysis.

In 1978, routine dustfall samples were collected at stations 17002, 17004 and 17005 while TSP samples were collected at station 17006 every sixth day (sampling station locations are shown in Figure 1). In an attempt to obtain a better understanding of the levels of particulates and the relative significance of emissions from the quarry operations of Stelco, BeachviLime and Domtar a more intensive sampling program was conducted from October, 1978 through July, 1979.

Additional dustfall jars and TSP samplers were deployed at stations 17011, 17012, 17013 and 17014. Also, a dustfall jar was located at station 17016 and in December, 1978 a jar was sited at station 17006. In May, 1979 a TSP sampler was installed at station 17018. Throughout this special investigation wind speed and wind direction measurements were made at 10 metres above ground level at station 17006. Sampling for dustfall and TSP had to be prematurely terminated at station 17011 in January, 1979. The locations of the various sampling stations are shown in Figure 2 and Table 1 describes the physical features at each site. Station 17014 is located on property owned by Domtar while the other stations are located outside the limits of property owned by the companies.

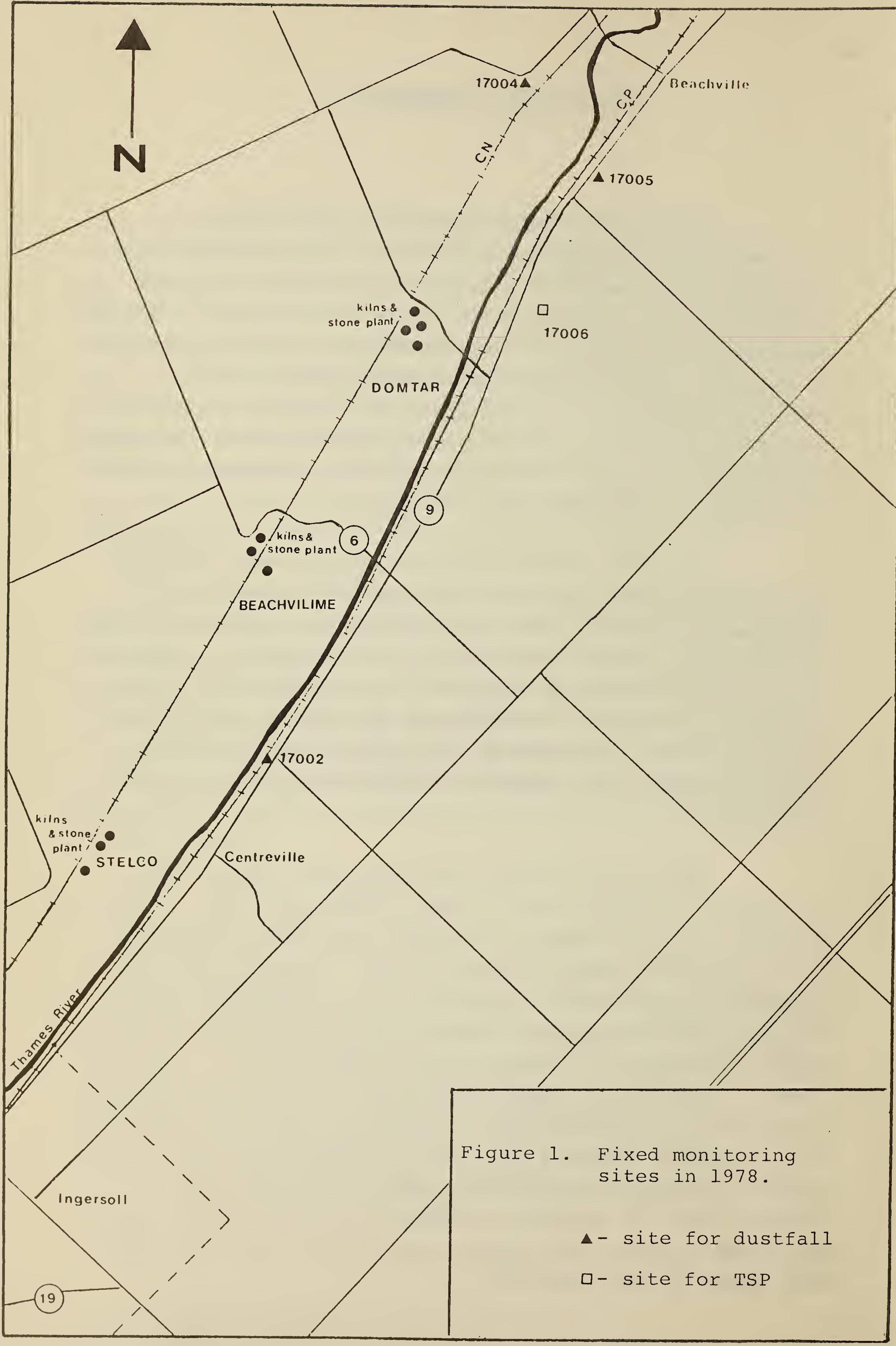

Figure 1. Fixed monitoring sites in 1978.

▲- site for dustfall

□- site for TSP

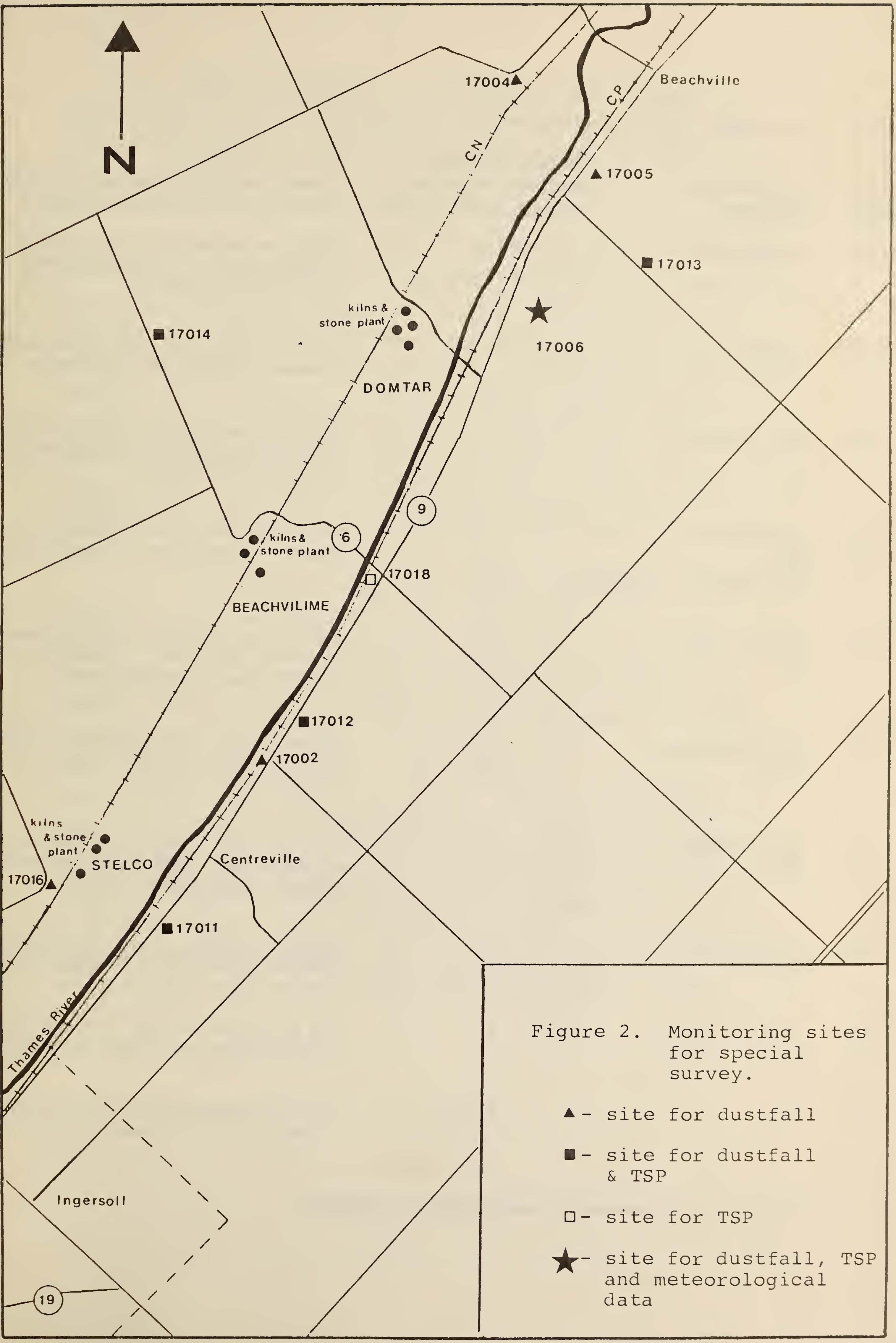

Figure 2. Monitoring sites for special survey.

Table 1. Description of monitoring sites

Station Number	Montioring Equipment	Height of sample collection above ground level (metres)	Distances (1) in metres to suspecte prime sources of particulates
17002	Dustfall jar	1.5	25 m. to paved road; 750 m NE of Stelco; 900 m S of BeachviLime; 2200 m SSW of Domtar
17004	Dustfall jar	3	3 m to paved road; 40 m S of house chimney; 1,400 m NNE of Domtar
17005	Dustfall jar	3	60 m to paved road; 8 m to gravel driveway; 40 m to house chimneys; 1250 m NE of Domtar
17006	Dustfall Jar TSP Wind speed & direction	6 6 10	70 m to paved road; 650 m E of Domtar, 2,200 m NE of BeachviLime
17011	Dustfall jar TSP	1.5 1.5	20 m to paved road, 20 m to house chimney, 550 m SSE of Stelco; 1750 m SSW of BeachviLime.
17012	Dustfall jar TSP	1.5 1.5	20 m to paved road, 25 m to house chimney; 750 m SSE of BeachviLime; 1000 m ENE of Stelco.
17013	Dustfall jar TSP	1.5 1.5	5 m to paved road; 30 m NNW of gravel road; 1200 m ENE of Domtar, 2500 m NE of BeachviLime.
17014	Dustfall jar TSP	1.5 1.5	300 m to gravel road; 1200 m W of Domtar, 1300 m NNE of BeachviLime.
17016	Dustfall jar	4	15 m to gravel road; 350 m SW of Stelco; 1800 m SSW of BeachviLime
17018	TSP	1.5	15 m to paved road; 70 m to gravel road, 600 m E of BeachviLime

(1) Distances are from processing operations of companies.

Special studies, to collect 6-hour samples of TSP upwind and downwind of sources of particulate, were conducted utilizing the samplers sited at fixed locations and portable samplers that were placed in strategic locations.

There are many sources of particulate emissions associated with quarry and processing operations including drilling, crushing, and screening of limestone, kilns, loading of trucks and trains, trucking, stripping of overburden and disposal of fine wastes. Traffic on quarry and county roads running through the quarry operations can result in appreciable emissions of particulates if dust control measures are not adequately maintained. Normal road traffic also elevates particulate concentrations as do natural particulates such as pollen, vegetation and insects.

The design of dustfall samplers enables leaves and insects to be readily collected. The larger pieces of leaves, insects and branches are screened out prior to determining dustfall loadings. The TSP samplers are designed to minimize the collection of large particles and consequently they collect a lower proportion of insects and leaves than dustfall jars. When samplers are located near ground level they tend to collect a greater proportion of larger and heavier particulates and a greater percentage of particulates re-entrained into the atmosphere by road traffic. Samplers located well above ground level, such as at station 17006, tend to collect a greater proportion of the particulates emitted from stacks and smaller and lighter particulates that would be more aerodynamically stable.

RESULTS

DUSTFALL

Data for dustfall levels are contained in Table 2. Values greater than Ontario's criterion for desirable ambient air quality (7.0 grams per square metre per 30 days) are underlined. Data for dustfall samples collected in Goderich and at the Western Fair Grounds of London are also presented in Table 2 in order that levels for Beachville may be compared with those for a town where there are no major emissions and those from a larger metropolitan centre.

TOTAL SUSPENDED PARTICULATE MATTER

A summary of the data for total suspended particulate matter collected during 24-hour sampling periods is contained in Table 3. This table includes the frequencies of excursions above Ontario's criterion for desirable ambient air quality, i.e. 120 micrograms of suspended particulate matter per cubic metre of air (ug/m^3) during a 24-hour sampling period. Data for Goderich and London are presented for comparison purposes. Table 4 shows the frequencies of values above the criterion for each month.

Coefficients of correlation were determined between TSP data and corresponding data for wind direction and wind speed. Positive coefficients indicate an increase in TSP values associated with the specific wind direction or speed, while negative coefficients indicate a decrease in TSP levels associated with the corresponding wind direction or speed. Coefficients of ± 1.0 would reflect 100 per cent correlation. From the positive coefficients of correlation for wind direction, coefficients of determination were calculated which reflect the relative effect of the different wind directions on TSP levels at individual stations. The coefficients of correlation for both wind direction and calm conditions (wind speeds less than 5 kilometres per hour) appear in Table 5a. The coefficients of determination calculated from the positive coefficients of correlation appear in Table 5b and are plotted as pollution roses in Figure 3. The length of the line indicates the relative effect of the different wind directions while the direction of the line towards the circle indicates wind direction. The number within the circle is the coefficient of determination for calm conditions.

There was an insufficient amount of data for station 17018 to determine coefficients of correlation.

The results of the investigations that utilized portable TSP samplers are presented in Figures 4 through 10.

DISCUSSION

DUSTFALL

The criterion for desirable ambient air quality with respect to dustfall is 7.0 grams per square metre per 30 days ($g/m^2/30$ days). This criterion was exceeded by 49 of the 82 dustfall samples collected in the Beachville area from October, 1978 through July, 1979. This represents a much higher frequency of excursions above the criterion than is experienced at monitoring stations with relatively clean air quality (Goderich). Also, as one would anticipate average concentrations are higher than experienced at stations with clean air quality.

There is a greater frequency of excursions above the criterion during the summer months, which is to be expected since drier conditions persist and there is no snow cover to curtail re-entrainment of dust into the air.

TOTAL SUSPENDED PARTICULATE MATTER

With the exception of TSP data for station 17011, the frequencies of values of TSP greater than the 24-hour criterion for desirable ambient air quality were appreciably greater in the Beachville area than that experienced in areas of relatively low levels of TSP (Goderich). Also, with the exception of station 17011, average concentrations of TSP were appreciably higher in the Beachville area. In fact, frequencies of excursions and average concentrations in the Beachville area tend to be higher than experienced at the Western Fair Grounds in London, a site affected by significant emissions from sources in all wind directions rather than those associated with specific wind directions as is the case at Beachville. Station 17014, which was farther from the quarries and processing operations than the other sampling stations, generally experienced lower concentrations of TSP than the other stations. Station 17013 was sited on a hill in a residential area that is exposed to emissions from the quarries and processing operations and station 17006 was sited on top of a building, while the other stations were located at lower ground levels.

The TSP sampler at Station 17018 was operated for only May, June and July, 1979 but 67 per cent of its samples were above the 24-hour criterion for desirable ambient air quality. Much of the elevated levels are probably attributable to emissions from BeachviLime and truck traffic on County Road 6.

There were greater frequencies of excursions above the 24-hour criterion during the summer. During June and July frequencies of 67 and 57 percent were experienced, respectively, compared to the average of 31 percent for all samples at all sites.

The amount of TSP determined for each sample depends on the particulates emitted into the air and the subsequent dispersion of the particulates. The dispersion of the particulates is greatly dependent on meteorology. In southwestern Ontario the meteorology is such that poorer dispersion conditions are frequently associated with the backs of high pressure systems moving from the south and southwest. Consequently, levels of pollutants, including TSP, tend to be higher with southerly to southwesterly winds unless there are overriding significant sources of emissions in a different wind direction. Coefficients of correlation and determination developed from data for wind direction and TSP from the period of October, 1978 to July, 1979 show that the emissions from the quarries and processing operations can override the dispersion conditions that can be associated with southerly and southwesterly winds.

The coefficients of correlation contained in Table 5(a) and the coefficients of determination presented in Table 5(b) and Figure 3 show that sampling stations which were south and east of the quarry operations did not tend to experience an increase in particulate levels with southerly winds. However, there was a tendency for some of these stations to have increased levels associated with south-southwesterly to westerly winds which could reflect both the poor dispersion conditions associated with the backs of high pressure systems and emissions from the quarry operations. In contrast, the coefficients for station 17014, which was located north and west of the quarry operations, showed a strong influence of southerly to southeasterly winds which also would reflect the combination of poor dispersion and emissions from the quarry operations.

The TSP sampler at station 17006 was located 6 metres above ground level and would tend to have been more impacted by particulates from elevated sources such as stacks and by particulates that were more aerodynamically stable than the TSP samplers at stations located 1.5 metres above ground level. The coefficients of determination indicate a strong influence from Domtar's emissions on particulate levels at station 17006. This is the only station for which a negative coefficient of correlation is reported for calm conditions, thus suggesting an increase when wind blows the plumes toward the station. While the coefficients of determination for the other stations suggest an influence from the quarry and overburden removal of Domtar and quarry and processing operations of BeachviLime, the specific relationships are less precise owing to the lower elevations of the samplers and the complexity of sources.

The quarry and processing operations were also implicated through the association of values of TSP greater than the 24-hour criterion and the relative frequencies of wind direction. For example, Table 6b shows that for station 17006, 66 percent of the winds blowing from the west during sampling periods and 69 percent of the winds blowing from the west-southwest (the directions in which processing operations of Domtar are located) are associated with TSP samples above the 24-hour criterion.

Visual observations of exposed filters from stations 17006, 17012, 17013 and 17018 revealed particulates of a colour typically associated with the quarries and processing operations.

SPECIAL STUDIES

May 22, 1979

From 10:30 a.m. until 4:30 p.m. on May 22, 1979 ambient air samples of suspended particulate matter were collected at 6 sites. The site locations and the levels of TSP obtained are shown in Figure 4. Wind direction was essentially easterly for the duration of the sampling period with wind speeds being 5 to 7 kilometres per hour (kph).

The two highest levels of TSP (320 and 350 ug/m^3) were collected downwind of County Road 6, which at the time of the study had not been treated for dust control. Based on visual observations the traffic, especially truck traffic, was contributing heavily to the levels of TSP. Also, road construction at the corner of County Roads 6 and 9 was contributing to these high levels of TSP. Company roads had been treated for dust control. Upwind of the quarries and processing operations and remote from County Road 6, measured levels of TSP were 71 and 98 ug/m^3. Downwind of processing operations of BeachviLime, Domtar's operations to remove overburden and County Road 6, the TSP level was measured at 167 ug/m^3, roughly twice the upwind concentrations. Downwind of Domtar's processing operations the level of TSP was measured at 127 ug/m^3.

May 30, 1979

From 10:30 a.m. until 4:30 p.m. on May 30, 1979 ambient air samples of TSP were collected from 6 sites in the Beachville area. The locations of the sites and the levels of TSP measured are shown in Figure 5.

During the early part of the sampling period, winds were generally calm (less than 4 kph) with some prevalence of northeasterly winds. For the last part of the sampling period winds were stronger (up to 7 kph) and southerly. The mixture of wind conditions makes it difficult to interpret the analytical results.

Rain had fallen the day prior to the sampling period thus greatly reducing emissions created by road traffic.

June 11, 1979

TSP samples were collected at 6 sites from 10:00 a.m. until 4:00 p.m. on June 11, 1979. The sampling locations and levels of TSP measured are shown in Figure 6. Moderately strong (14 to 18 kph) northerly winds persisted.

This study was intended to determine some of the effects of emissions from BeachviLime on TSP levels. TSP levels upwind of BeachviLime ranged from 50 to 74 ug/m^3 while those downwind ranged from 101 to 278 ug/m^3. County Roads 6 and 9 had recently been treated for dust control. In addition to normal point sources of particulate emissions such as the gravel bed filter serving the No. 1 rotary kiln of BeachviLime, there was considerable fugitive dust being created by a front end loader cleaning up waste fines and excessive leakage from the tailgate of a truck transporting waste to the north quarry.

June 29, 1979

TSP samples were collected at 7 sites from 9:00 a.m. to 3:00 p.m. on June 29, 1979. The sampling locations and analytical results appear in Figure 7. Winds were relatively calm (2 to 7 kph) and southeasterly for the start of the sampling period and more southerly for the last half of the sampling period. Rain fell for approximately 1 hour in the middle of the sampling period.

TSP levels were mixed upwind and downwind of BeachviLime and Domtar and no effects from emissions from the plants could be determined. The air cleaning action of the rain plus the shift in wind direction would tend to lower the levels of TSP attributable to any specific source.

July 6, 1979

TSP samples were collected from 7 sites between 10:00 a.m. and 4:00 p.m. on July 6, 1979. The sampling locations and analytical results appear in Figure 8. Northwesterly winds persisted at 8 to 12 kph.

The levels of TSP for the 4 samples collected downwind of the quarries and processing operations ranged from 263 to 289 ug/m^3. The level for the sample collected upwind of the quarries was 134 ug/m^3, while the values for samples collected to the east of the quarries were 94 and 233 ug/m^3. The 233 ug/m^3 appears to be atypical and may have been affected by some very localized activity or impingement by a plume for a brief period of time.

The 4 values for the sites downwind of Domtar and BeachviLime are well above the 24-hour criterion for desirable ambient air quality and reflect the unsatisfactory air quality to which residents living along that section of County Road 9 are periodically exposed.

Company roads were maintained in a well watered state throughout the sampling period. Blasting in the north quarry of Domtar created fugitive emissions of particulates. Fugitive emissions were also originating from the tertiary screening plant and the limestone surge pile serving the rotary kilns of BeachviLime. The more persistent plumes from point sources at BeachviLime were from the stack serving the gravel bed filter of No. 1 rotary kiln, the stacks serving the electrostatic precipitators of the No. 3 rotary kiln and the stack serving the calcimatic kiln. For Domtar the more persistent point sources were observed to be stacks servicing No. 1, 2 and 4 shaft kilns and scrubber stacks serving No. 1, 2 and 3 rotary kilns and the No. 1 hydrate lime plant. The visible plumes from these scrubber stacks would contain a large proportion of innocuous condensed water vapour.

July 18, 1979

TSP samples were collected from 7 sites between 9:30 a.m. and 3:30 p.m. on July 18, 1979. The sampling locations and analytical results appear in Figure 9. Winds were from the north and north-northwest at 2 to 7 kph.

The highest level of TSP was 237 ug/m^3 which was collected downwind of County Road 6. Visual observations of dust created by truck traffic on this road were recorded on the day of sampling. This source of particulates might also have contributed to the slight elevation in concentration at the site for which 163 ug/m^3 was reported. The level of 82 ug/m^3 downwind of Domtar compares favourably with levels measured to the east and west of Domtar.

July 20, 1979

Two samples for TSP were collected between 9:30 a.m. and 3:30 p.m. on July 20, 1979. Sampling locations and analytical results appear in Figure 10. Winds were variable, being from the west-northwest, south, and south-southeast at speeds from 2 to 9 kph.

Unfortunately, the results of this sampling program, which was intended to indicate effects of emissions from Stelco, were complicated by the shift in wind direction. Consequently, no upwind or downwind sampling sites persisted.

Visual observations during the sampling period included fugitive emissions of particulates from truck traffic on approach and dyke roads and from the dumping of overburden at the east end of the property. Visible emissions from point sources were minor in nature.

CONCLUSIONS AND RECOMMENDATIONS

The frequency of unsatisfactory levels of dustfall and total suspended particulate matter is excessive on residential properties located close to the quarries along County Road 9 between Beachville and Centreville and the newer residential area located in southeast Beachville.

Man-made sources of particulates that are contributing to these elevated levels are:

1. Traffic on county and company roads, especially when dust control measures are not maintained.
2. Fugitive emissions from such operations as stripping of overburden and the handling and transporting of fines and waste.
3. Point sources associated with the processing operations, in particular those having opacities in excess of that stated in Regulation 15 of The Environmental Protection Act, 1971.

It is recommended that:

1. Investigations be conducted into the presently employed dust control measures for both company and county roads with the goal of optimizing the frequency and effectiveness of control measures.
2. Domtar Inc., BeachviLime Limited and Stelco investigate sources of fugitive emissions such as the handling of fines and implement measures for maintaining control over these emissions.

3. Abatement programs, where necessary, be developed for Domtar Inc., BeachviLime Limited and Stelco to bring the opacity of emissions into compliance with Regulation 15. Emissions containing large amounts of water vapour should be evaluated by some alternative means such as stack sampling.

APPENDIX I

Table 2. Levels of dustfall

Station Number	Dustfall loadings (gm/m^2/30 days)											
	October 1978	November	December	January 1979	February	March	April	May	June	July	No. greater than criterion	Average loading
17002	6.2	7.0	3.4	6.1	5.9	5.8	8.3	7.6	8.5	11.1	4	7.0
17004	5.1	6.6	3.2	7.7	4.5	6.8	9.5	6.9	17.0	16.2	4	8.4
17005	7.2	11.2	9.4	15.0	5.7	2.8	5.8	12.0	12.4	2.9	6	8.4
17006			8.5	13.3	6.3	8.7	7.3	6.5	7.2	4.9	5	7.8
17011	6.4	5.7	5.6	4.3	--							5.5
17012	7.4	10.3	5.8	8.0	10.8	5.9	7.1	10.5	10.3	13.3	8	8.9
17013	10.5	11.3	5.4	6.1	8.7	7.1	12.5	17.5	14.8	13.5	8	10.7
17014	8.1	5.9	5.5	13.9	4.3	7.2	11.4	9.9	15.3	12.3	7	9.4
17016	5.8	7.5	6.8	7.1	8.5	6.9	11.5	8.5	10.8	10.3	7	8.4
Goderich												
10015	2.7	1.9	2.0	1.8	1.2	2.5	6.0	3.0	3.1	2.6	0	2.7
15001 Western Fair Grounds London	2.4	2.4	--	1.3	2.5	6.5	7.1	5.4	4.6	3.4	1	4.0

Table 3. Summary of data for total suspended particulate matter

Station Number	No. of samples collected	No. of values >120 ug/m^3	Percentage of values >120 ug/m^3	Average Concentration (ug/m^3)
17006	48	13	27	107
17011	27	1	4	58
17012	47	18	38	98
17013	47	21	45	132
17014	45	9	20	81
17018	12	8	67	135
Goderich 10015	42	5	12	66
London 15001 Western Fair Grounds	43	9	21	86

NOTE (1) Samples collected from October 1978 through July, 1979 except for shorter periods at stations 17011 and 17018

(2) 120 ug/m^3 is Ontario's 24-hour criterion for desirable ambient air quality

Table 4. Frequencies of values for total suspended particulate matter above the criterion for desirable air quality

Station	Number of values greater per number of samples collected									
Number	October/78	November	December	January/79	February	March	April	May	June	July	Total
17006	0/4	0/8	3/5	3/5	2/5	2/5	0/4	1/4	0/3	2/5	13/48
17011	0/5	1/10	0/5	0/5	0/2						1/27
17012	1/5	3/10	2/5	1/4	3/5	1/5	1/4	1/1	3/4	2/4	18/47
17013	2/5	3/10	1/4	2/5	2/4	1/5	1/3	2/3	3/3	4/5	21/47
17014	1/5	1/10	1/5	1/5	0/2	0/5	1/4	1/4	2/3	1/2	9/45
17018								1/2	4/5	3/5	8/12
Total	4/24	8/48	7/24	7/24	7/18	4/20	3/15	6/14	12/18	12/21	70/226
Percent	17	17	29	29	39	20	20	43	67	57	31

Table 5(a). Coefficients of correlation between TSP data and wind direction and calm conditions

Station	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Calm
17006	-0.03	-0.24	-0.23	-0.37	-0.26	-0.13	-0.09	-0.14	-0.17	-0.07	0.27	0.66	0.67	0.06	-0.25	-0.24	-0.26
17011	0.10	0.23	0.11	-0.11	-0.25	-0.29	-0.05	I.D.	-0.25	-0.06	-0.13	-0.13	-0.36	-0.08	0.03	-0.10	0.48
17012	0.10	0.04	0.00	-0.31	-0.35	-0.15	-0.01	-0.04	-0.13	0.25	0.10	0.08	0.15	-0.14	-0.32	-0.20	0.29
17013	-0.10	-0.10	-0.21	-0.41	-0.36	-0.14	0.09	0.09	-0.04	0.13	0.19	0.02	0.12	-0.07	-0.10	0.09	0.17
17014	-0.23	-0.15	-0.18	-0.22	-0.17	0.11	0.63	0.54	0.30	0.20	0.01	-0.15	-0.30	-0.28	-0.22	-0.09	0.24

NOTE: I.D. indicates insufficient relative data

Table 5(b). Coefficients of determination determined from positive corefficients of correlation

Station	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Calm
17006											0.07	0.44	0.45	<0.01			
17011	0.01	0.05	0.01												<0.01		0.23
17012	0.01	<0.01								0.06	0.01	0.01	0.02				0.08
17013							0.01	0.01		0.02	0.04	<0.01	0.01			0.01	0.03
17014						0.01	0.40	0.29	0.09	0.04	<0.01						0.06

Table 6(a). No. of hours wind blew from different directions when samples of TSP were greater than 24-hr. criterion for desirable ambient air quality

Station Number	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Calm
17006	5								2	12	42	104	51	15	7	2	65
17011													1				23
17012	5	10	9	5	1	2	7	6	17	54	42	48	34	9	4	6	171
17013	5				1	2	7	7	20	41	71	63	36	15	17	12	196
17014				1	1	2	7	6	14	29	30	15	1				105
17018	3				1	2	6	5	10	12	9	6	6	7	17	12	72
Total hours for all sampling periods	28	33	21	40	65	14	13	15	56	76	103	151	77	50	89	35	369

Table 6(b). Percentage of winds for various directions during all sampling periods associated with TSP values above 24-hr. criterion

Station(1) Number	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Calm
17006	18(2)								4	16	41	69	66	30	8	6	18
17012	18	30	43	13	2	14	54	40	30	71	41	32	44	18	4	17	46
17013	18				2	14	54	47	36	54	69	42	47	30	19	34	53
17014	0			3	2	14	54	40	25	38	29	10	1				28

(1) insufficient data for stations 17011 and 17018

(2) 18% of northerly winds were associated with TSP values >120 ug/m^3 at station 17006 (5/28 x 100%)

APPENDIX 2

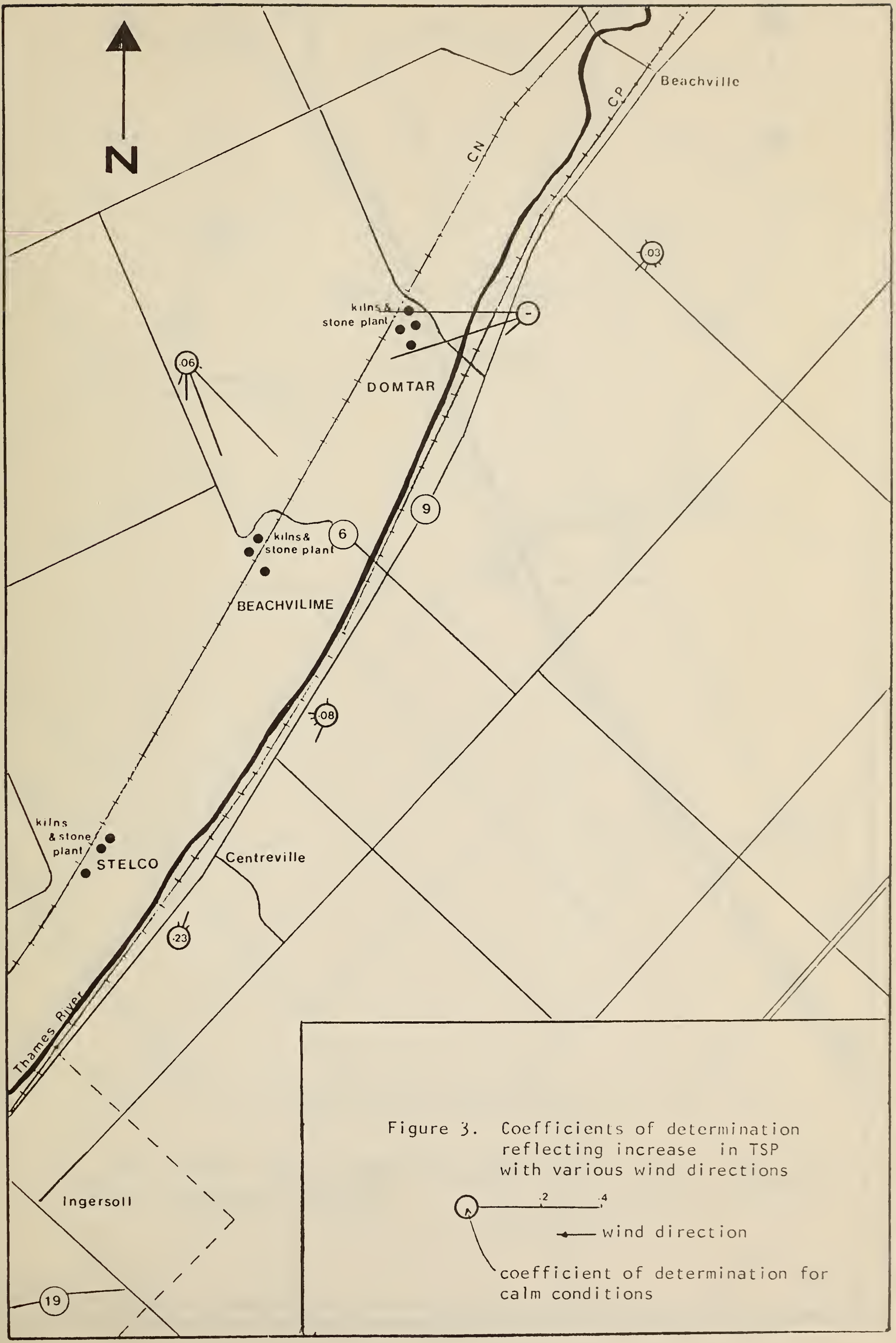

Figure 3. Coefficients of determination reflecting increase in TSP with various wind directions

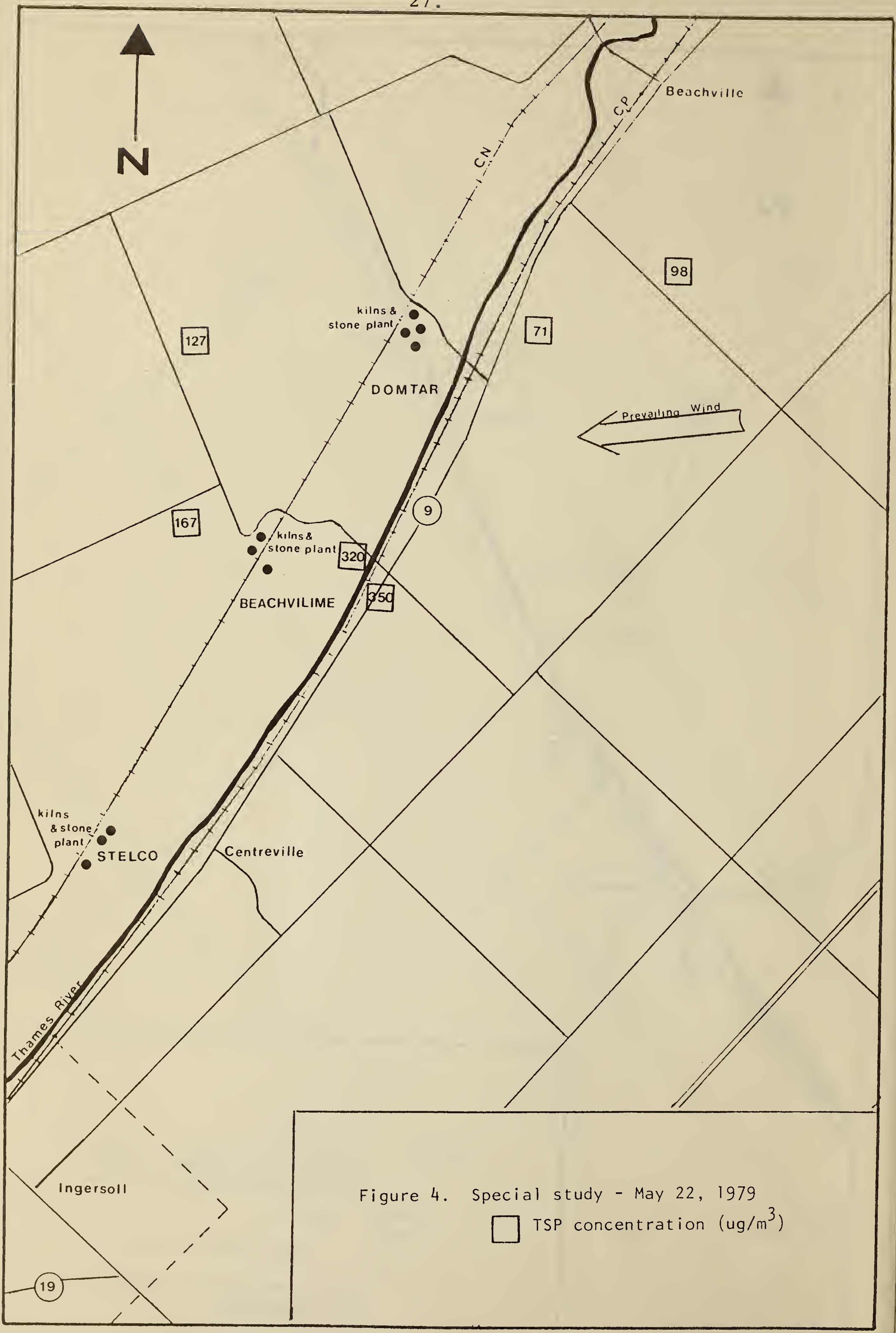

Figure 4. Special study - May 22, 1979

□ TSP concentration (ug/m^3)

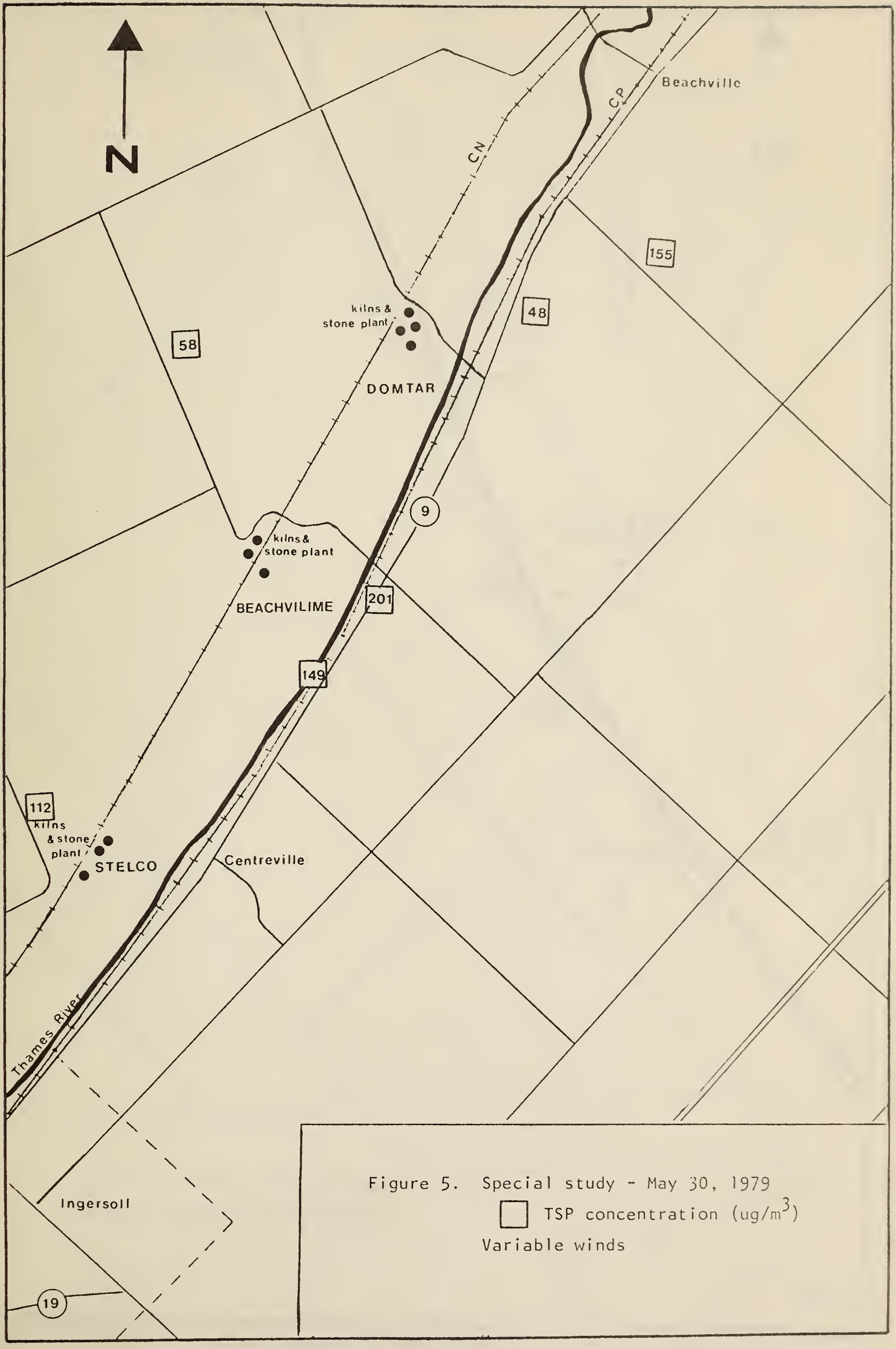

Figure 5. Special study - May 30, 1979

☐ TSP concentration (ug/m^3)

Variable winds

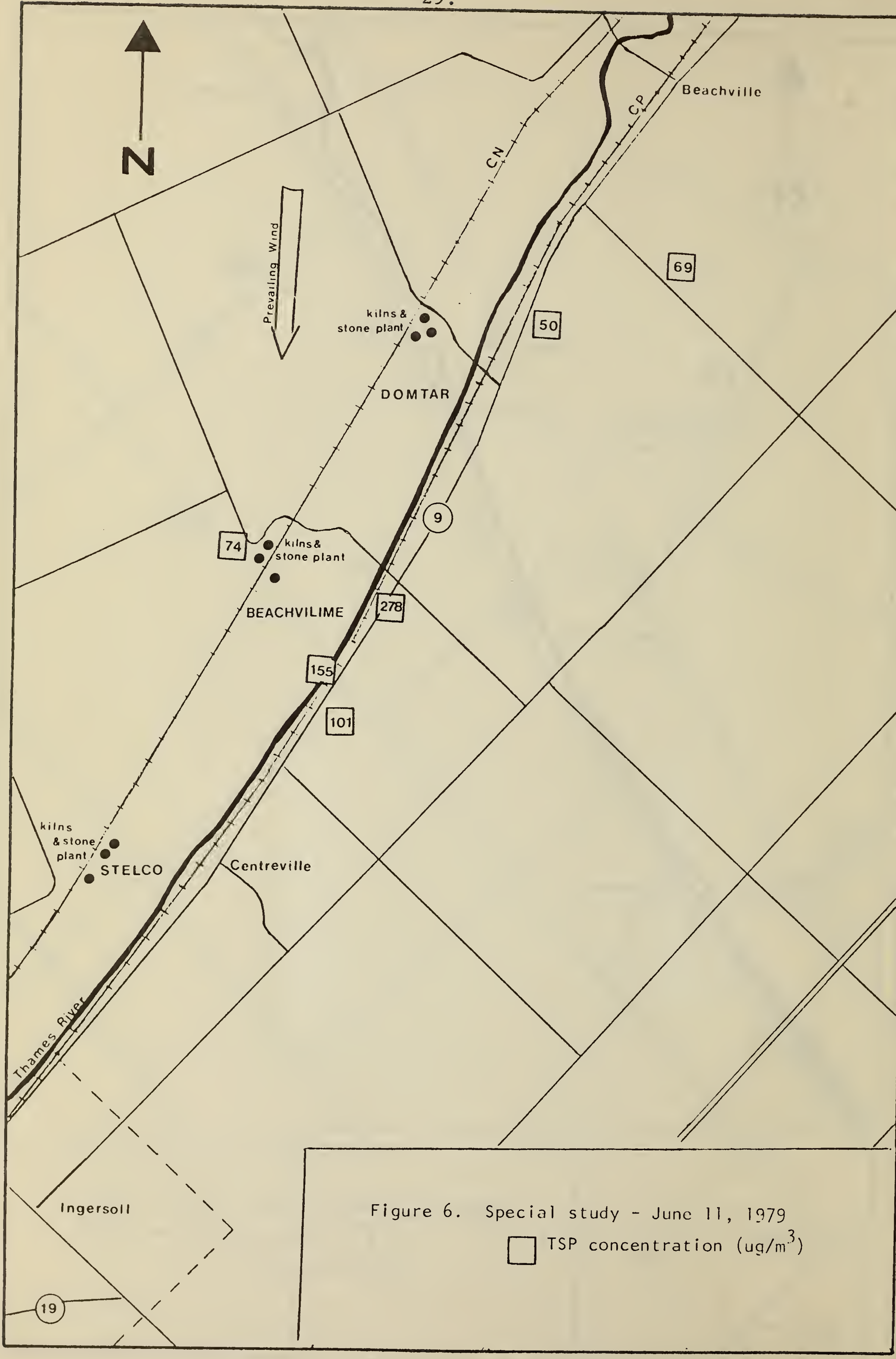

Figure 6. Special study - June 11, 1979

☐ TSP concentration (ug/m^3)

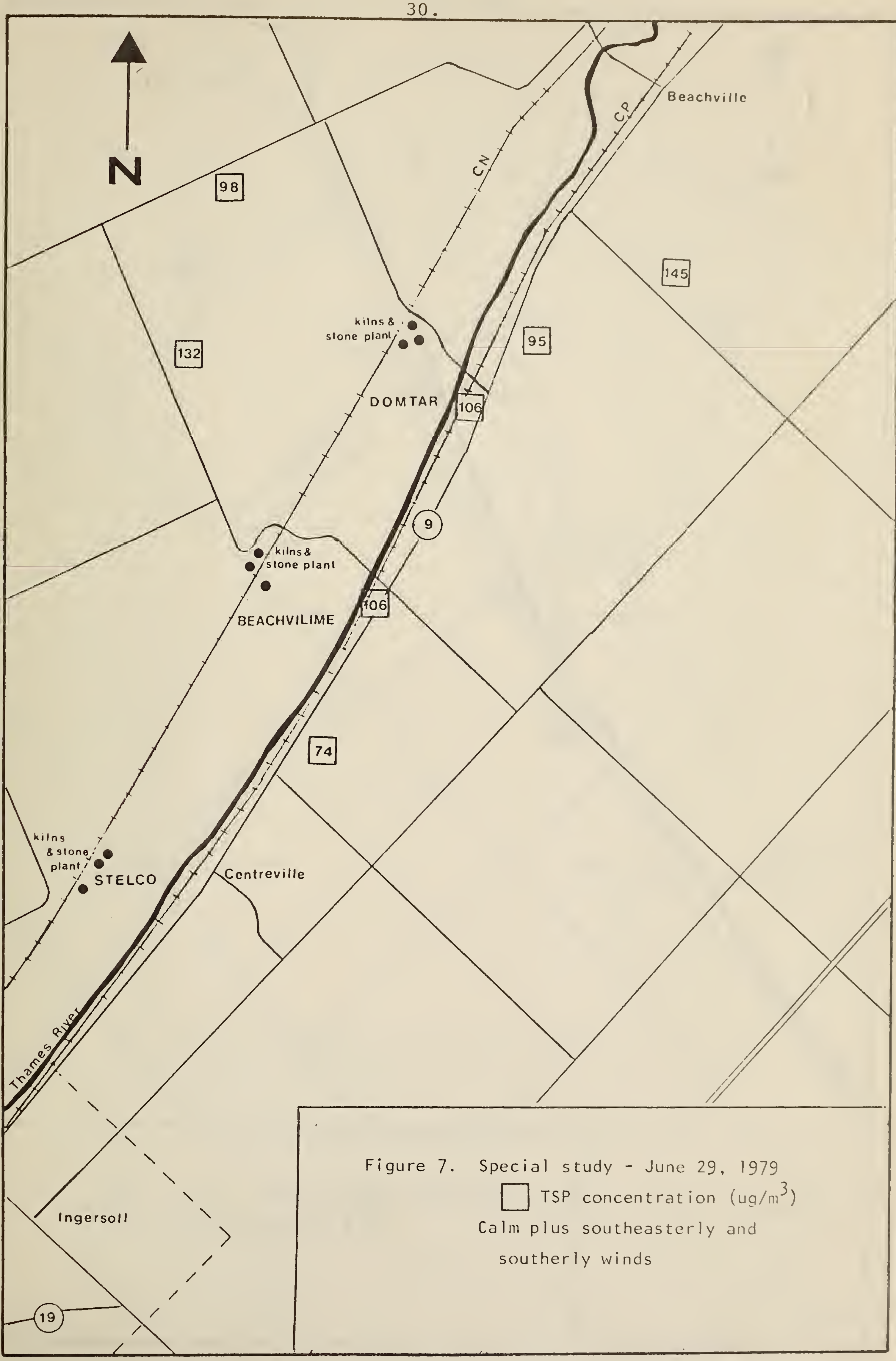

Figure 7. Special study - June 29, 1979

☐ TSP concentration (ug/m^3)

Calm plus southeasterly and southerly winds

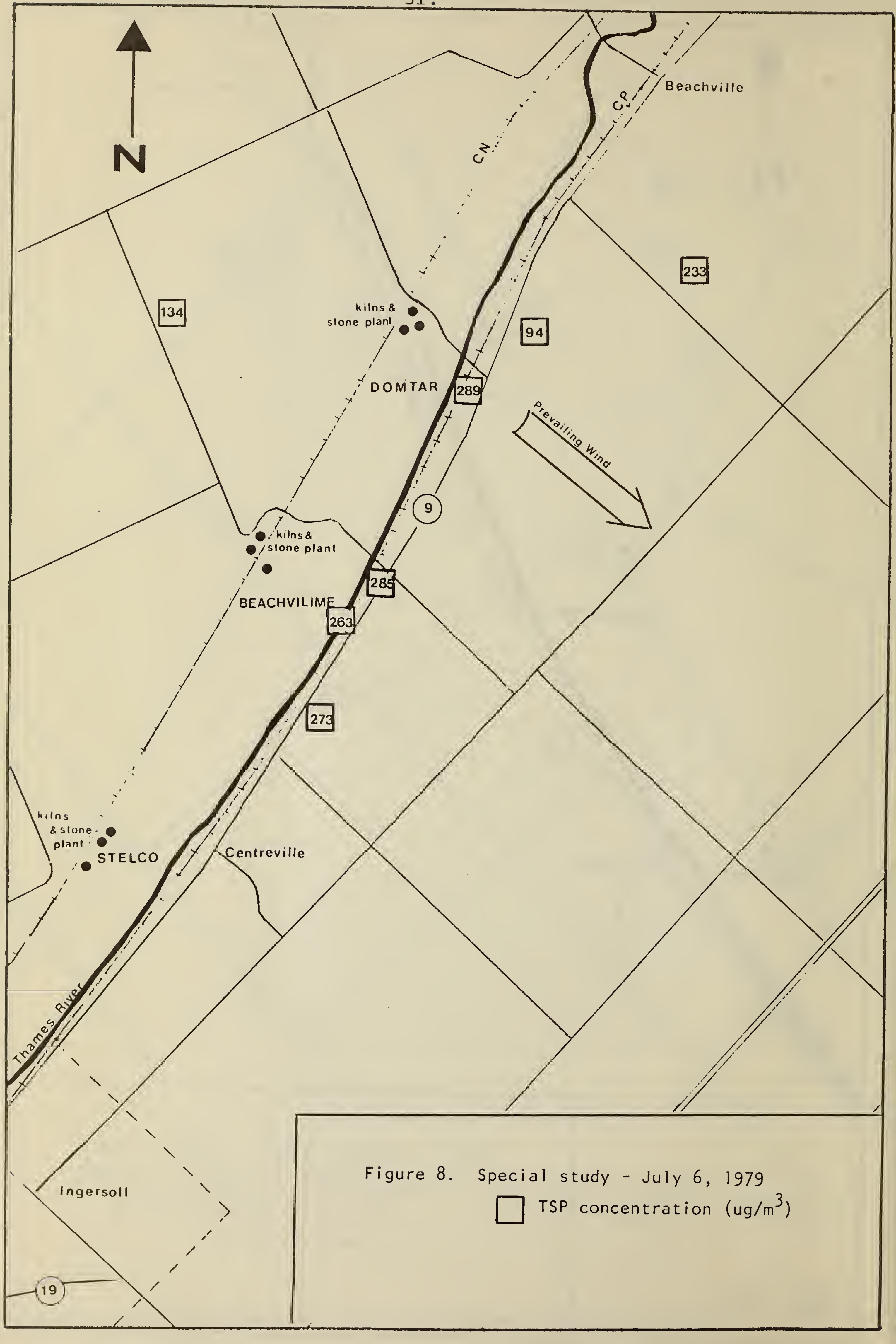

Figure 8. Special study - July 6, 1979

☐ TSP concentration (ug/m^3)

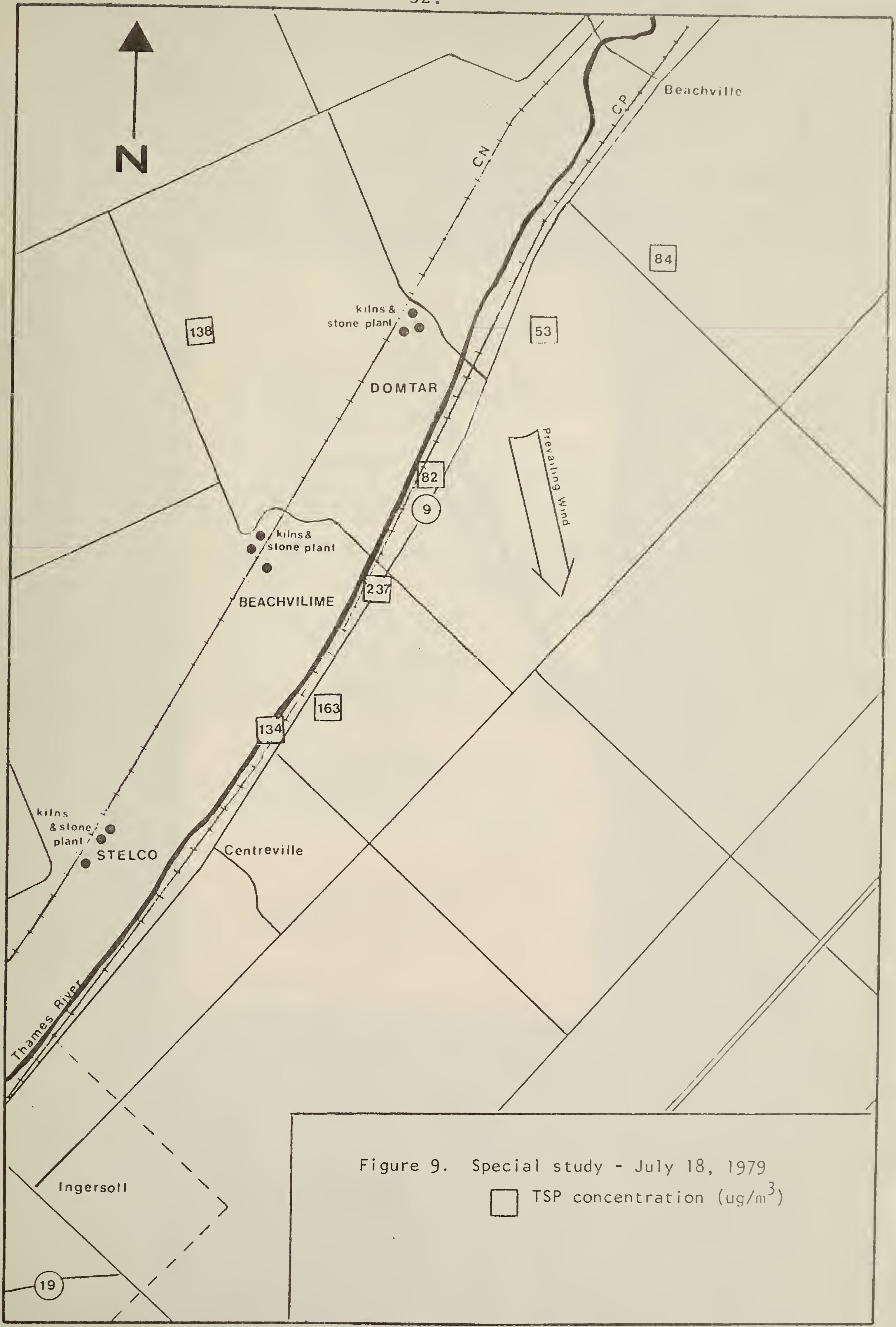

Figure 9. Special study - July 18, 1979

□ TSP concentration (ug/m^3)

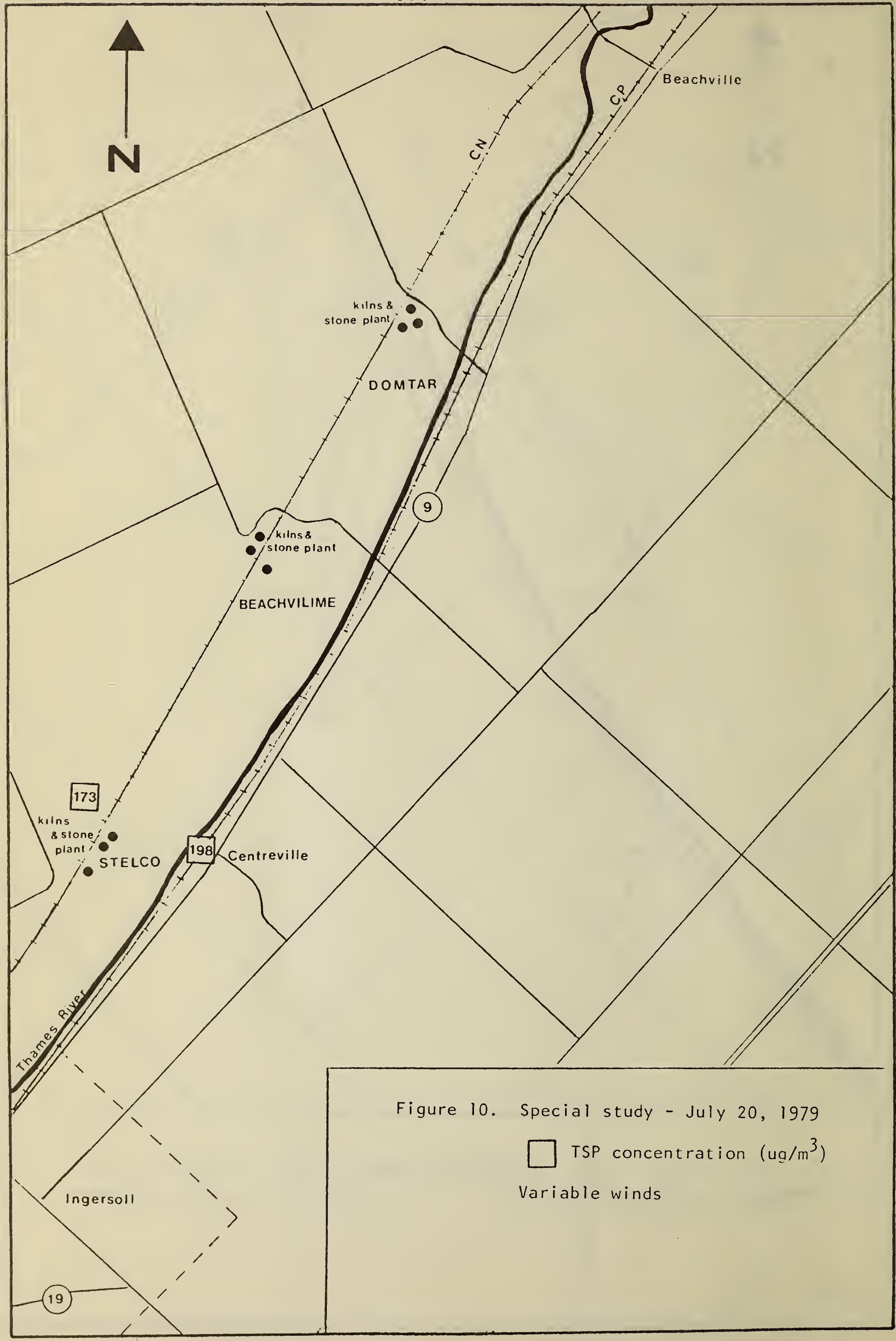

Figure 10. Special study - July 20, 1979

☐ TSP concentration (ug/m^3)

Variable winds

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